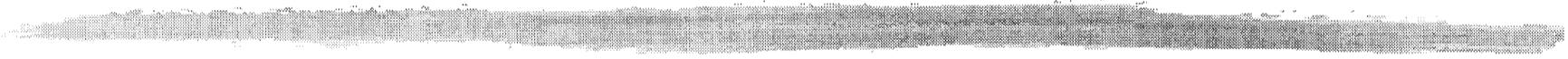


# **Aerosols, Clouds, and TES**

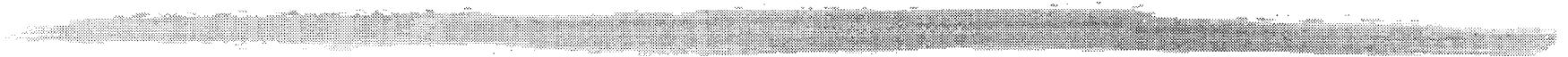


**Annmarie Eldering**

**Jet Propulsion Lab**

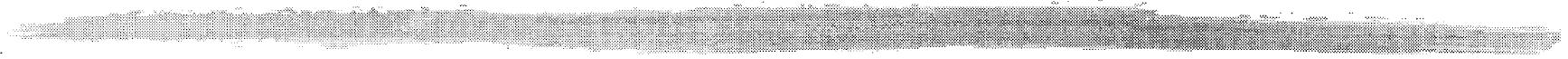
**California Institute of Technology**

# Question



- Will aerosols and clouds impact TES measurements
- Magnitude?
- Frequency?
- Types of materials?

# Background



- Aerosols and clouds scatter and absorb light
- Global aerosols include stratospheric sulfate, dust, anthropogenic pollutants
- Most current investigations focus on visible light

# Assessment techniques



- Examine observational IR data
- Extrapolate UV/vis observations
- Conduct simulations with radiative transfer models
  - Nadir case
  - Limb case

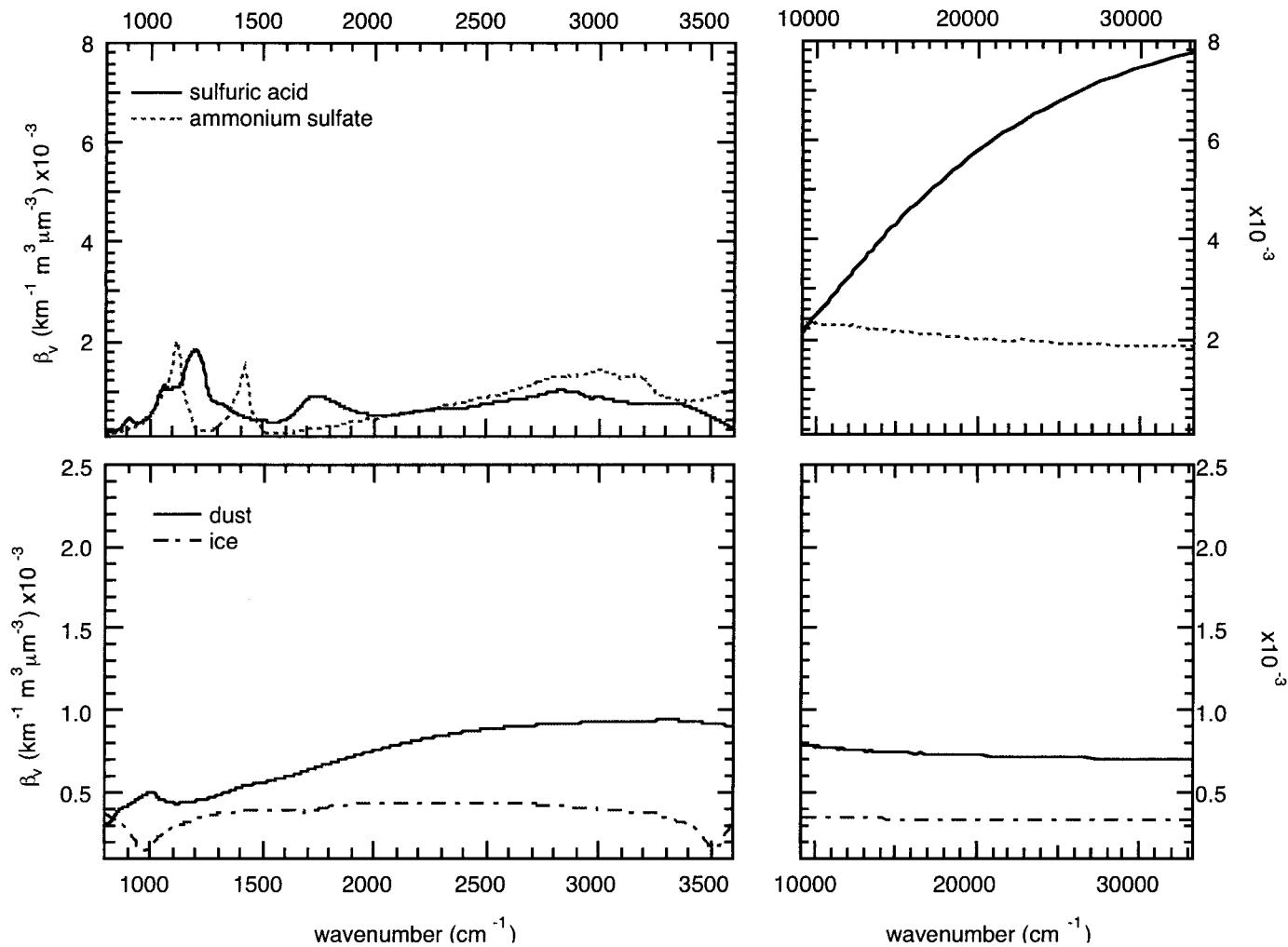


Figure 1: Extinction coefficients in the IR and visible for four common materials. Details of the aerosol descriptions are found in the table.  
Note that the IR and visible graphs for material groups are on the same scale, although the material groups are on different scales.

# Observations suggest



- The following cases may be important for nadir viewing
  - Dust storms
  - Large volcanic eruptions (SSA)
  - Clouds

# Observational evidence



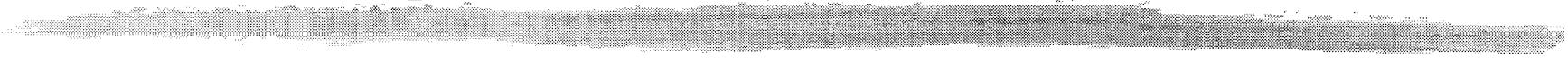
- Mesosat data over Senegal during dust storms
- HIRS/AVHRR/HIS after Mt. Pinatubo
- MIPAS-B for limb case

# RT model issues



- computational speed
- accuracy
- aerosol and cloud representation
- representation of phase function

# **Radiative transfer for scattering atmospheres**



- monte carlo
- spherical harmonics
- discrete ordinates
- adding-doubling

## ■ Monte Carlo

- | too computationally intensive to achieve desired accuracy

## ■ Spherical Harmonics

- | Provides intensity at all levels
- | Order of approximation and discretization impt
- | Computation increases with terms in phase function



## ■ Discrete ordinate

- | Yields internal radiation field
- | Provides internal reflection and transmission
- | Basis of DISORT program



## ■ Adding/doubling

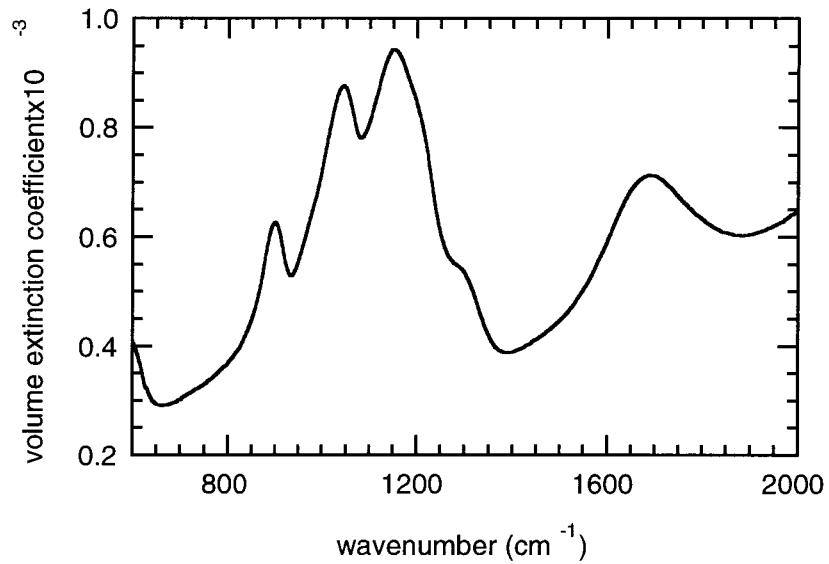
- | If reflection and transmission known for two layers, it is known for the combined layer
- | Provides intensity at one layer
- | CHARTS employs this techniques and augments calc to include observer angle

# Nadir modeling study

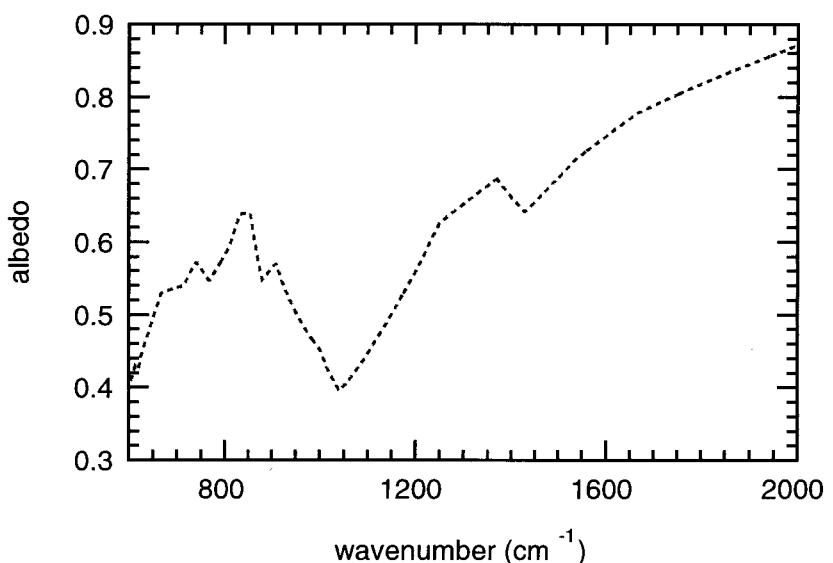
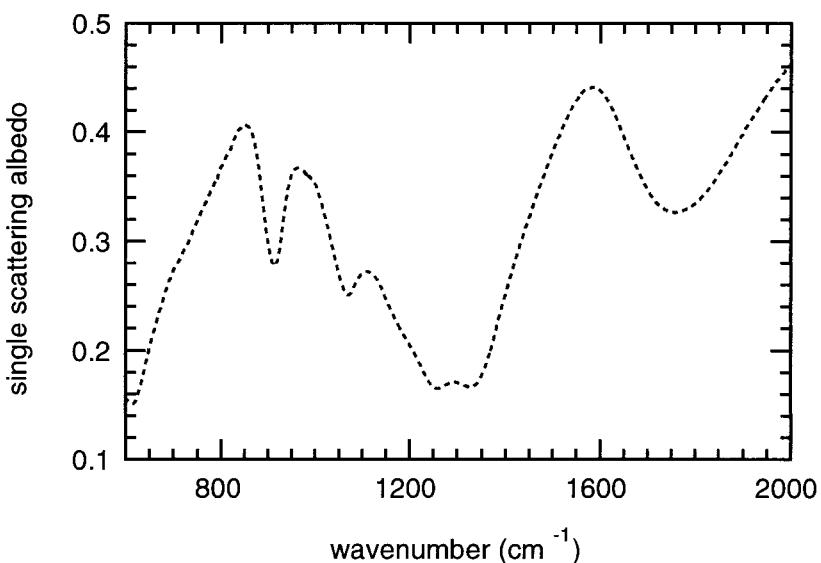
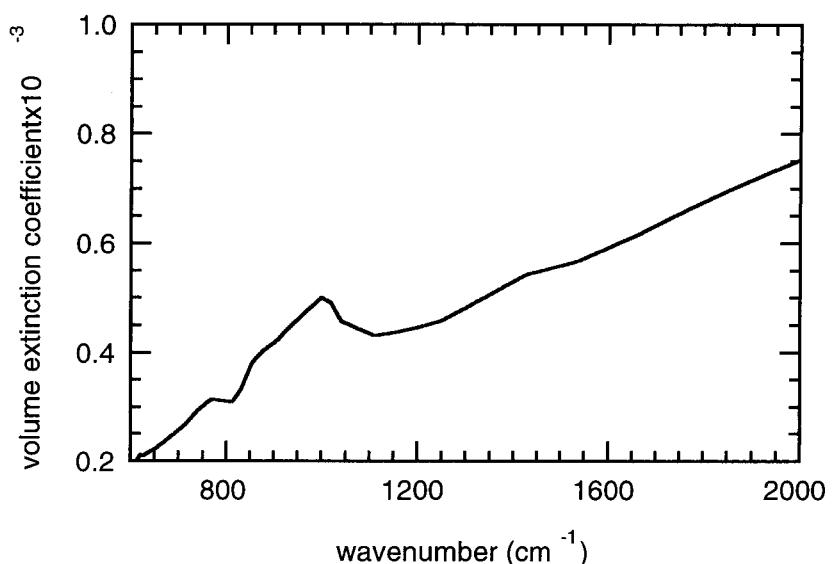
---

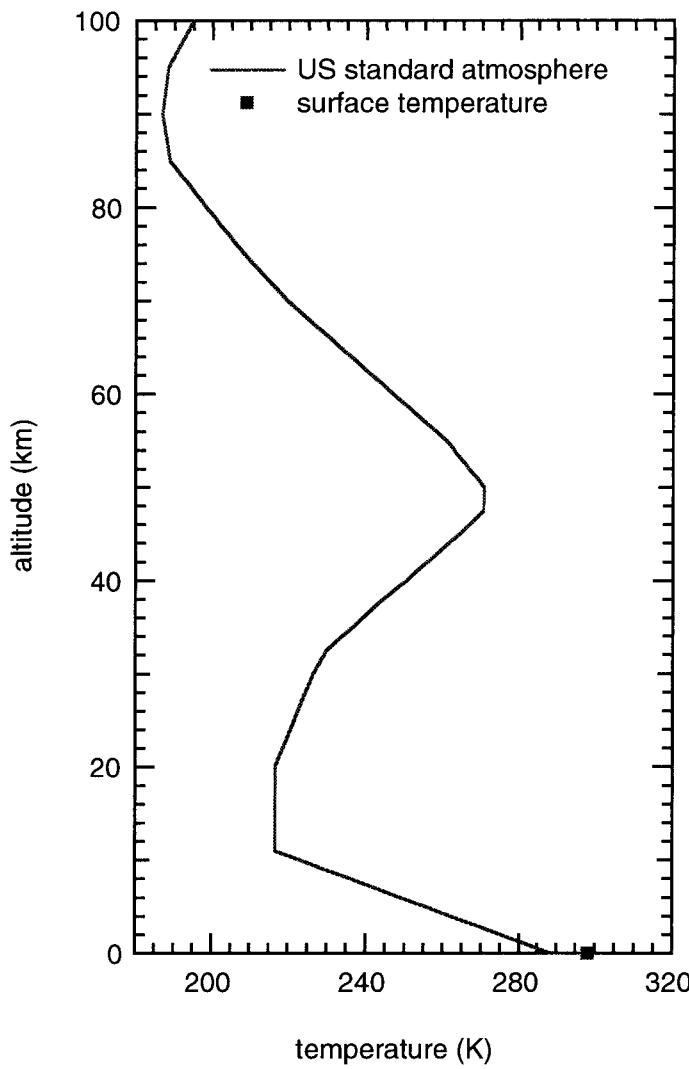
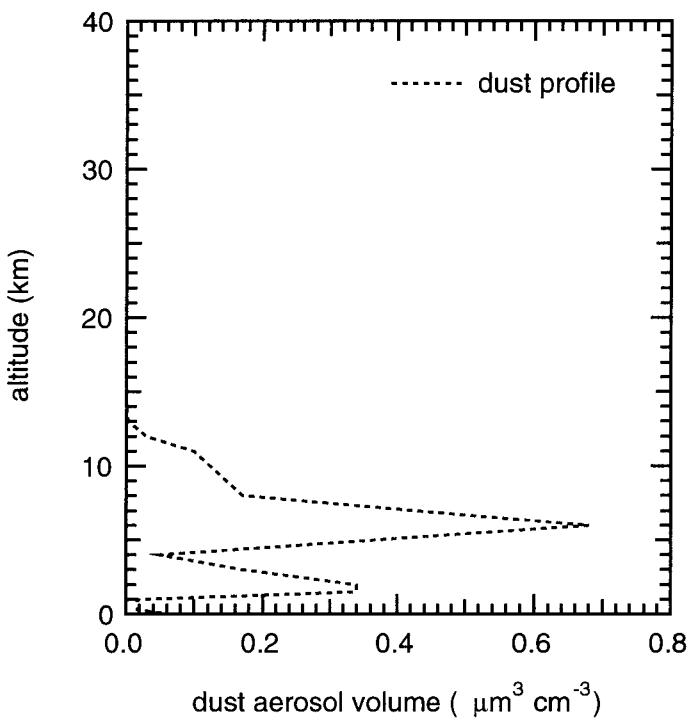
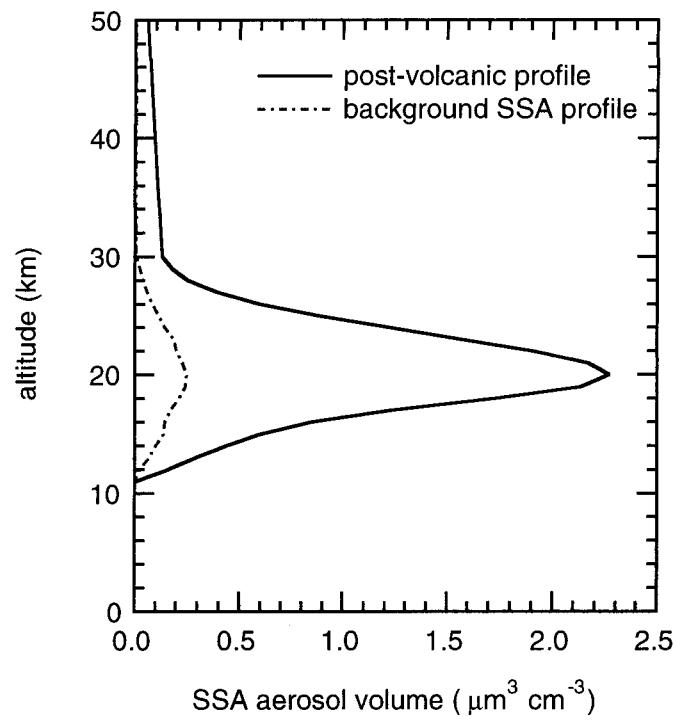
- Use CHARTS for nadir case
- Vertical profiles of dust and SSA from literature
- Optical properties from literature and recent lab measurements
- Focus on dust and SSA

SSA optical properties



dust optical properties





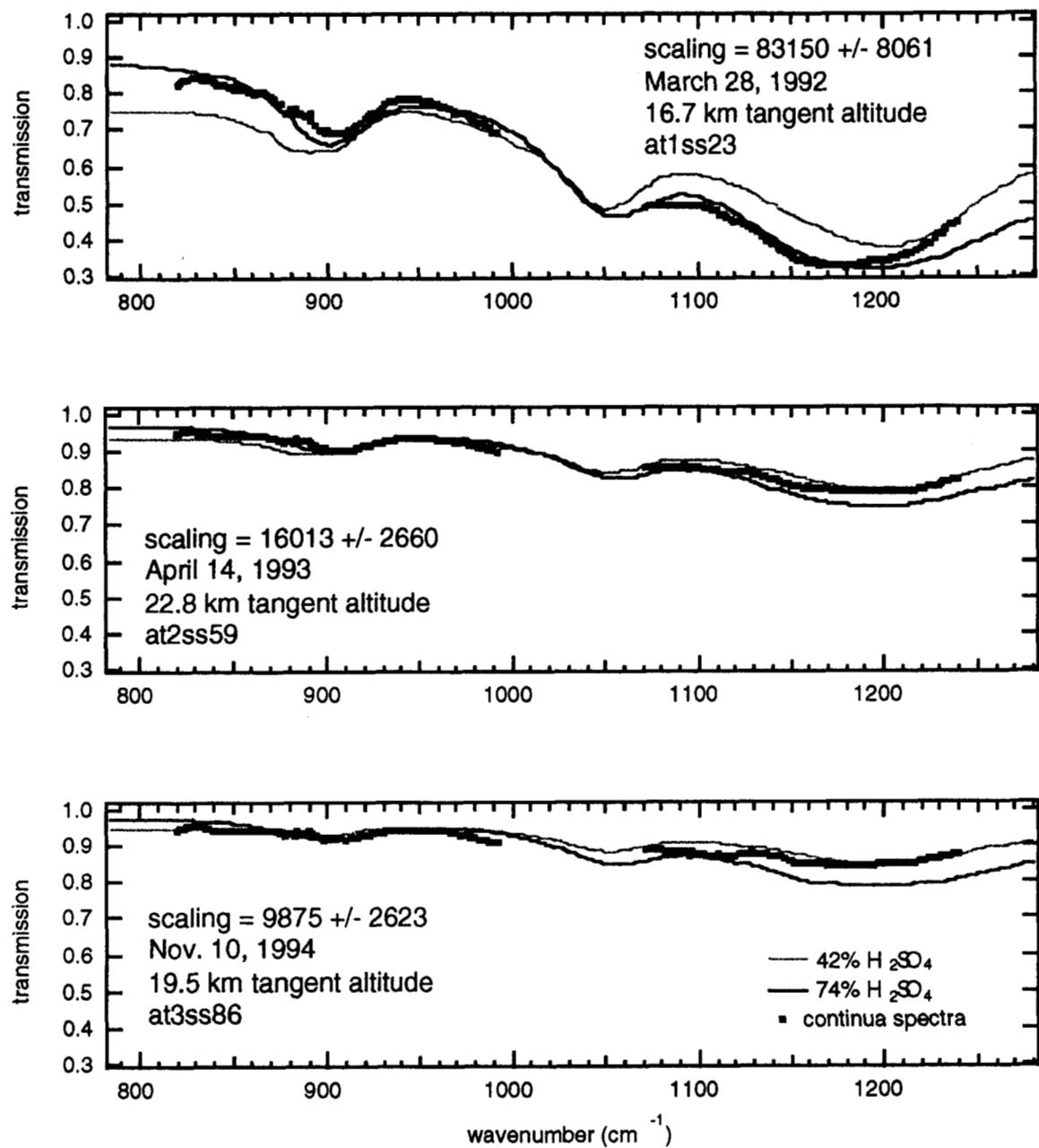
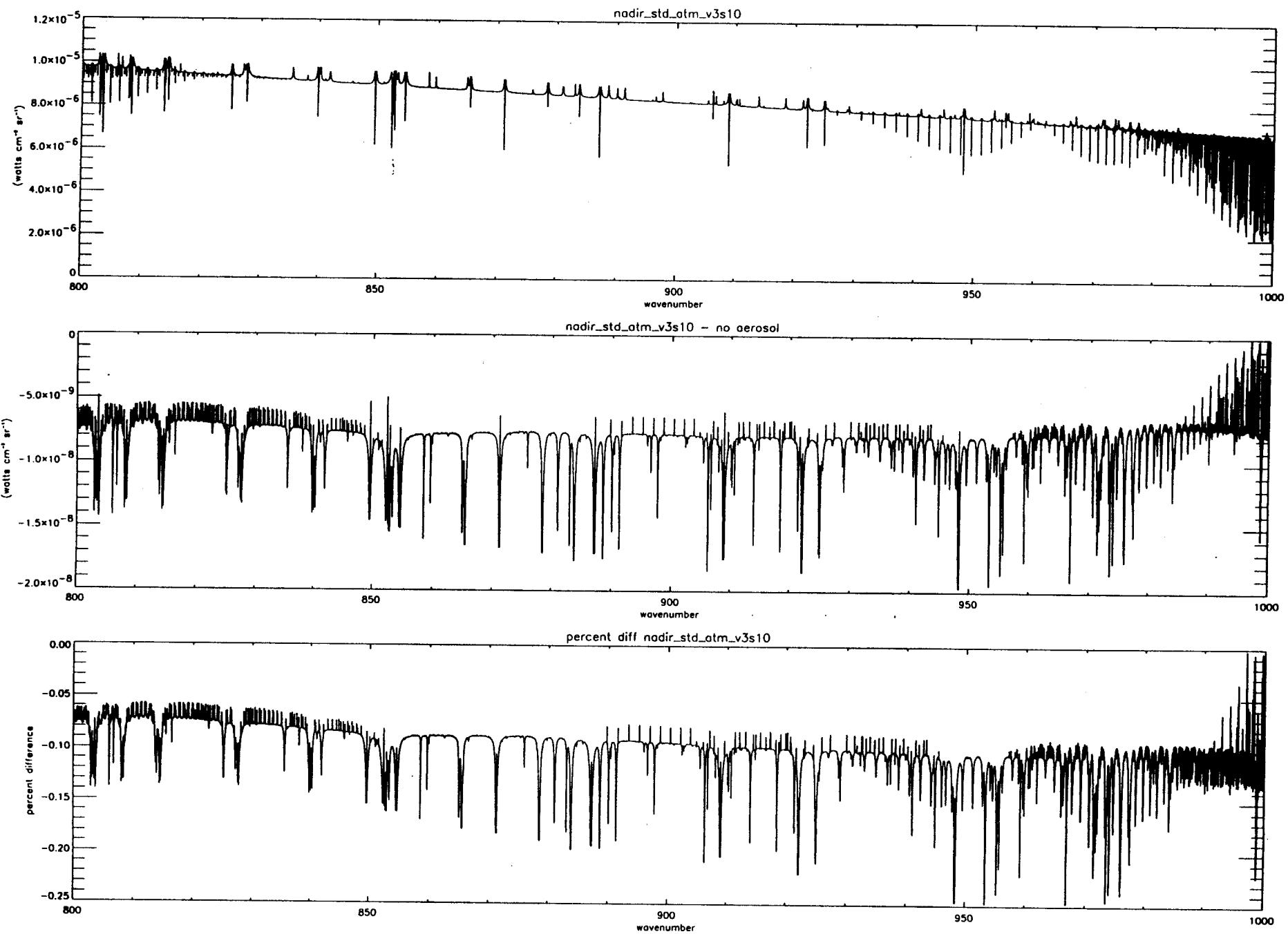


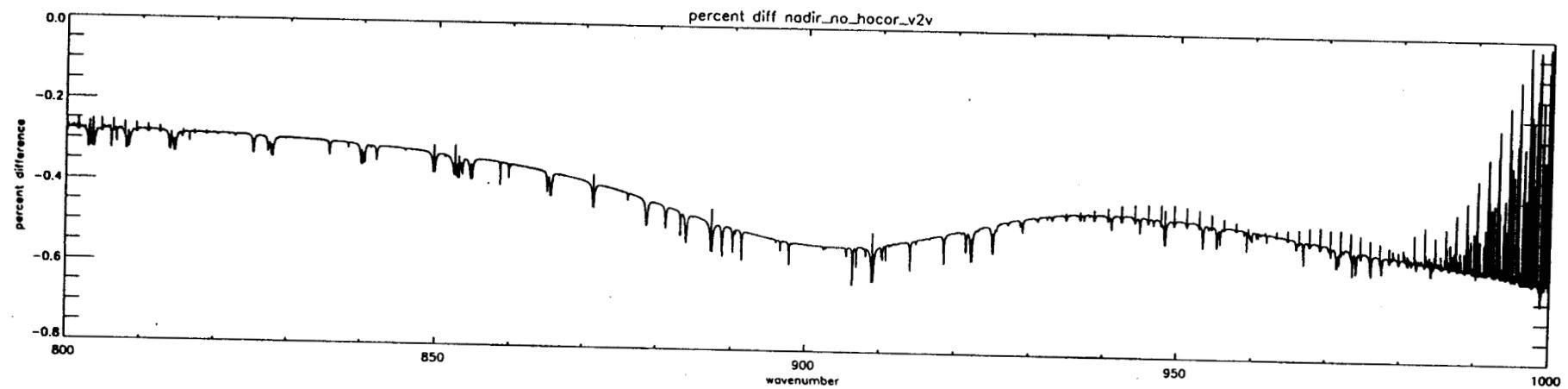
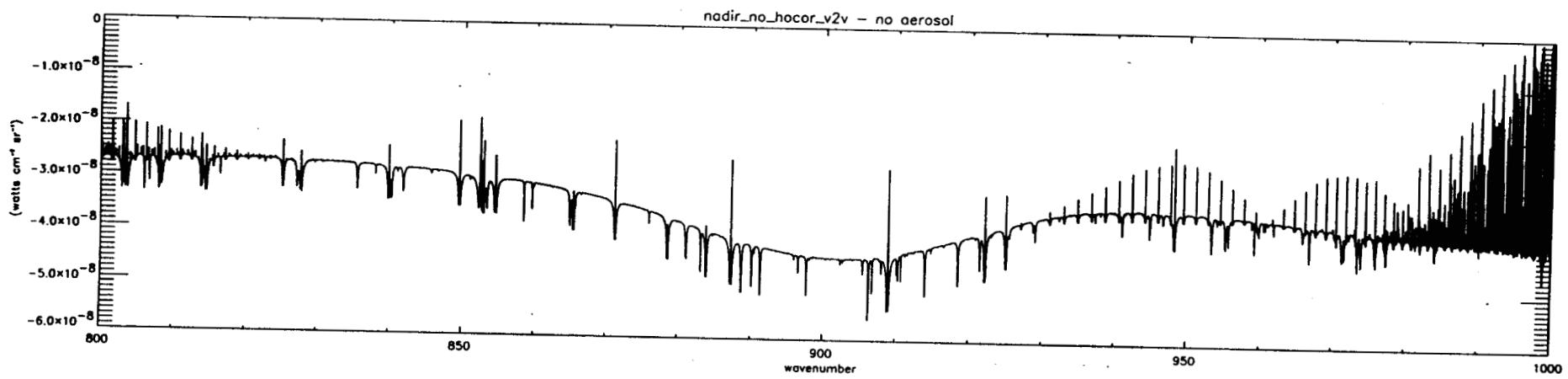
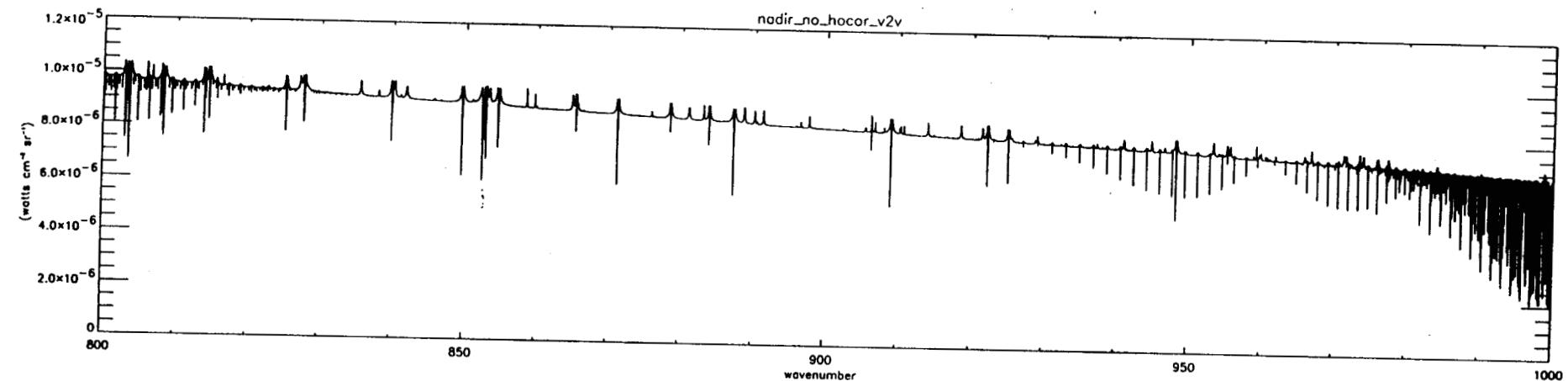
Figure 7. Comparisons of measured “continua spectra” to best-fit calculated spectra for two sulfuric acid compositions.

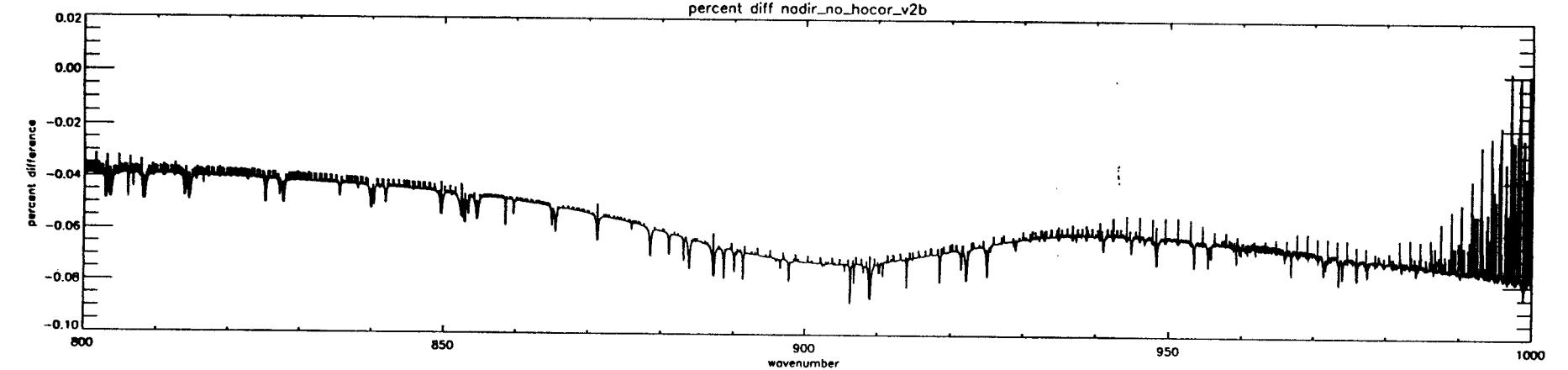
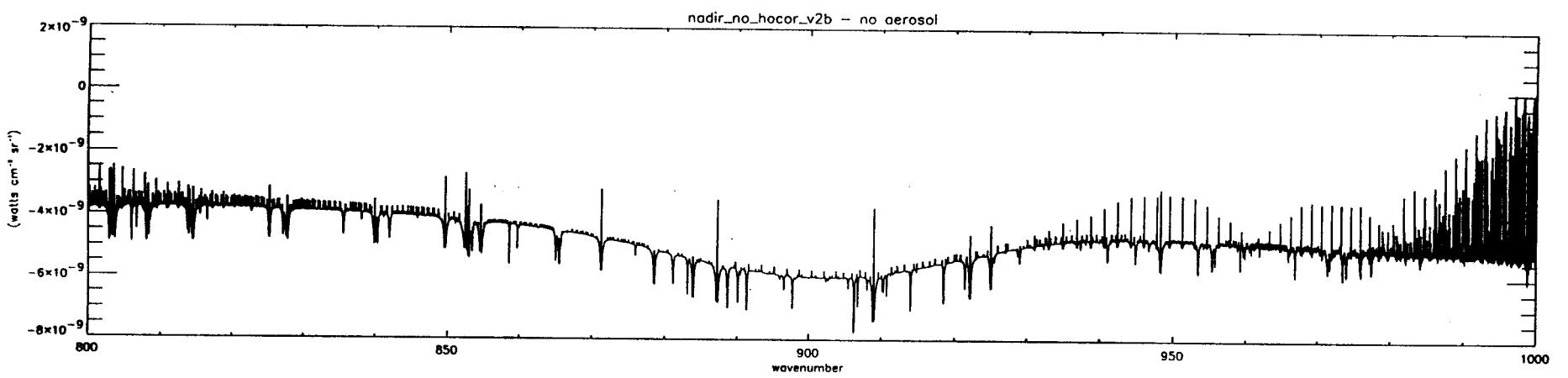
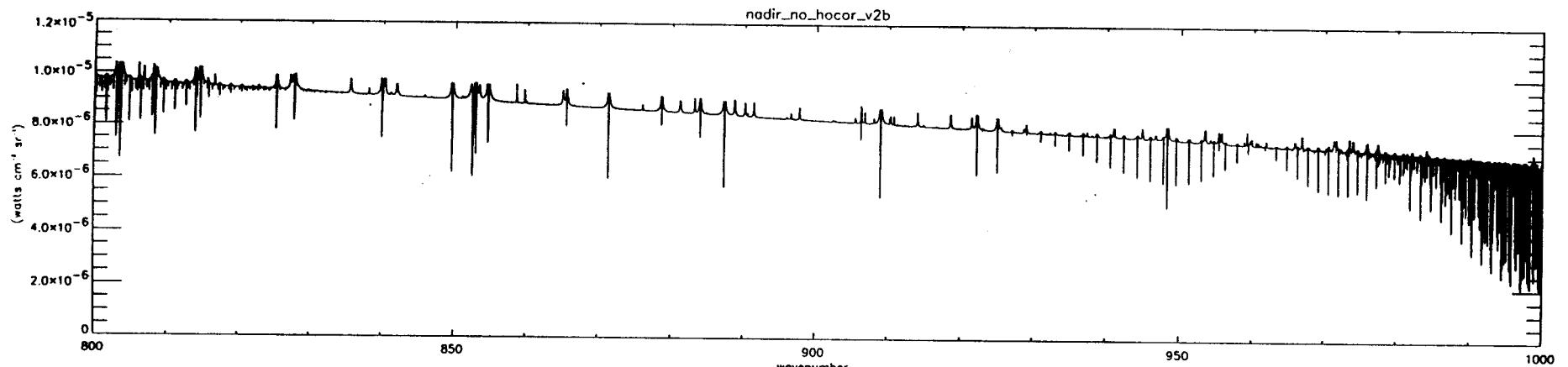
# Nadir results



- Set of calculations for scattering atmosphere using line by line RT and spectrally dependent aerosol optical properties





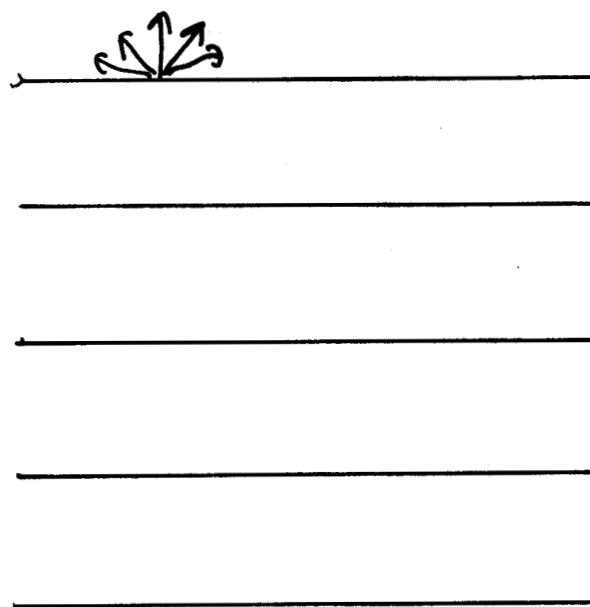


Label	Case	Vertical OD	Max relative diff (all values are negative)
No_hocor_v2b	Background volcanic aerosol	0.002	< 0.1%, with spectral shape
No_hocor_v2v	Post-volcanic aerosol	0.02	~0.6% with spectral shape
No_hocor_v2v20	Scaled volcanic aerosol (x2.0)	0.04	~1.2% with spectral shape
No_hocor_v2v30	Scaled volcanic aerosol (x3.0)	0.06	~1.7% with spectral shape
No_hocor_v2v45	Scaled volcanic aerosol (x4.5)	0.09	~2.8% with spectral shape
Off_nadir_150_v2v	Post_volcanic viewed at 150 (30 degrees off nadir)		~0.7% with spectral shape
Off_nadir_130_v2v	Post_volcanic viewed at 130 (50 degrees off nadir)		~1.0% with spectral shape
Nadir_std_atm_v3s30	Scaled tropospheric dust (x3)	0.006	~0.05% Relatively flat
Nadir_std_atm_v3s10	Scaled tropospheric dust (x10)	0.02	~0.12% Relatively flat

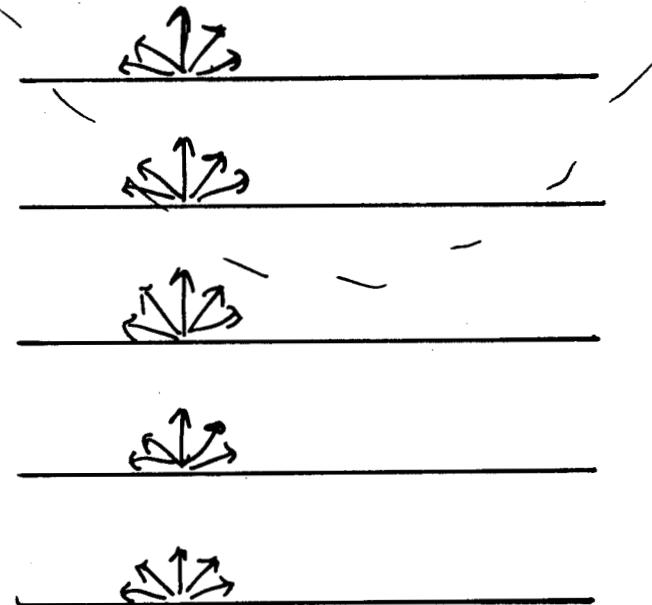
# Needs for limb case



- To integrate along the line of sight, a description of the radiation field at all layers is required
- Spherical harmonics or discrete ordinate can provide such information
- Phase functions important for scattering that is not near-forward



adding-doubling



spherical harmonics

discrete ordinates

# Summary



- Impact of dust and SSA for nadir geometry small, as expected
- Clouds need to be studied
- Limb geometry
- Phase function representation and other details of aerosol optical properties (albedo..)